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(54) **Voltage stabilizing during crank**

(57) The invention is directed to a voltage stabilizing system 300 for stabilizing the power voltage U_{batt} provided by an electric power storage 130 to an electrical system 150 and a starter motor 120 during crank of an engine 110 in a vehicle 1000. The stabilizing system 300 comprises a starter switch arrangement 124 and a control unit 140 configured to operatively establish and terminate a communication of power between the power storage

130 and the starter motor 120 of the vehicle 1000 to crank the engine 110. The control unit 140 is configured to operatively establish said communication of power during crank of the engine 110 such that the power provided from the power storage 130 to the starter motor 120 is repeatedly turned off for a period of time Δt_{off} each time the power voltage U_{batt} drops below a reference voltage U_{ref} .

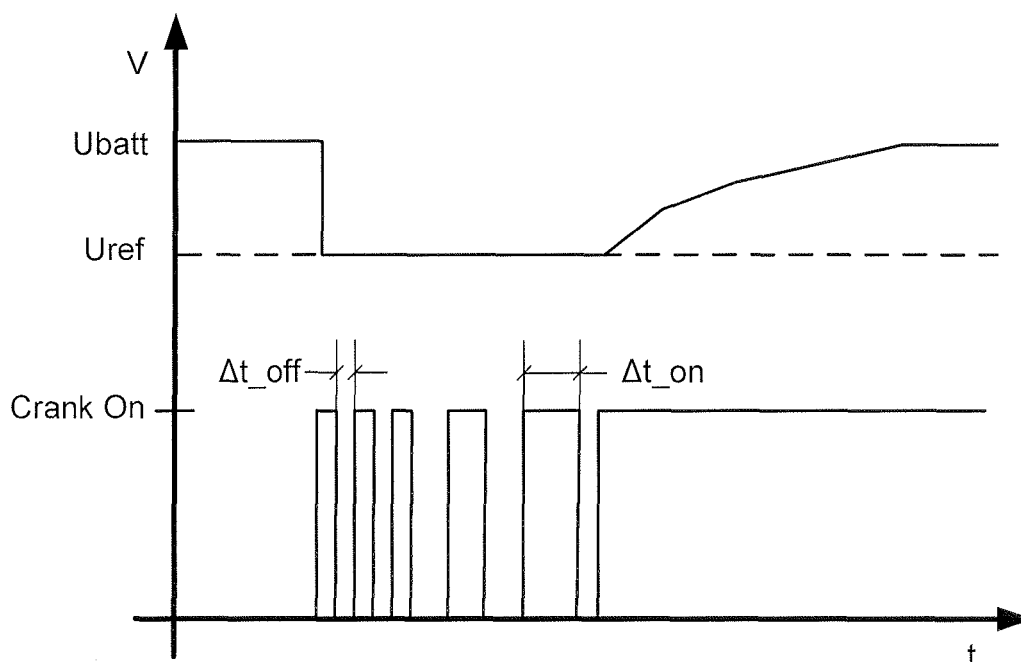


Fig. 2b

Description

TECHNICAL FIELD

[0001] The present invention relates to the ignition or so-called crank of a combustion engine in a motor vehicle. Embodiments of the invention are directed to an automated crank in a so-called start-stop vehicle.

BACKGROUND

[0002] During normal operation, the combustion engine in a traditional motor vehicle is only turned off at exceptional occasions and always when the vehicle is stationary.

[0003] However, to save energy it has become increasingly common to stop the combustion engine of the vehicle when the vehicle velocity is below or equal to a certain threshold value. The engine is then automatically started again when the driver intends to drive off and/or intends to increase the vehicle velocity. This can be detected *e.g.* by sensors reacting on *e.g.* clutch and/or break release and/or throttle pedal actuation etc. Vehicles arranged to operate in this or a similar manner is commonly called start-stop vehicles.

[0004] In a start stop-vehicle it is essential that the operation of the ordinary electrical systems of the vehicle is maintained after a turn off of the engine and the generator/alternator normally supplying these electrical systems. This is especially so if the vehicle is still cruising when the engine is turned off. The task falls upon the vehicle battery and the functions related thereto, which must be accordingly dimensioned.

[0005] When the engine in the start-stop vehicle is automatically restarted by the starter motor the voltage supplying the ordinary electrical systems of the vehicle will temporarily drop to *e.g.* about 5-7 Volts due to the high current consumption of the vehicle starter motor. This causes a reduced capacity or even a complete stop/reset of the ordinary electrical systems normally being supplied by the vehicle battery, *e.g.* at 12 Volts. This is not acceptable in a start-stop vehicle, since the ordinary electrical systems shall be kept operational and not subjected to a reset or similar. On the whole, the driver of the vehicle shall not experience any functional loss. This is in clear contrast to the operation of a traditional motor vehicle wherein power to the electrical system of the vehicle is temporarily turned off in a controlled manner when the vehicle engine is started by the starter motor.

[0006] There are various known solutions that avoid a drop in the voltage to the ordinary electrical systems in a conventional vehicle during actuation of the starter motor.

[0007] According to one known solution a first battery is used for the starter motor and a second battery is used for the ordinary electrical systems. During activation of the starter motor the starter motor and the first battery are disconnected from the second battery and the ordi-

nary electrical system. The first battery must have a large capacity due to the high current consumption of the vehicle starter motor. The second battery must also have a large capacity due to the current consumption of the vehicle electrical system, which may be considerable and potentially long-lasting. The current consumption may *e.g.* be long lasting when the vehicle engine and hence the vehicle electrical generator/alternator of the vehicle are turned off during parking at the same time as one or more of the electrical systems of the vehicle are still turned on, *e.g.* one or several of: the lights, the air condition, the windshield wipers, the infotainment system etc. Hence, both the first and the second battery must be able to store a high amount of energy and both batteries are therefore large, *e.g.* capable of storing more than about 75 or 100 Ah. The combined weight of the two full sized batteries has a detrimental effect of the CO₂ emission from the vehicle. Similarly, the use of two full sized batteries has a detrimental effect in terms of packaging in the vehicle. In addition, the overall cost of the vehicle increases when two batteries are used as described above.

[0008] According to another known solution a DC/DC converter is used for stabilizing the voltage provided to the ordinary electrical system during crank of the combustion engine of the vehicle in question. This solution may only need a single large battery, which would be an improvement compared to the double-battery solution discussed above. However, a DC/DC converter is a complicated and costly component which adds to the overall complexity and cost of the vehicle.

[0009] In view of the above there is a need for an improved crank of motor vehicles according to which at least one of the drawbacks identified above is eliminated or mitigated.

SUMMARY OF THE INVENTION

[0010] An object of the present invention is to eliminate or mitigate at least one of the drawbacks identified above.

[0011] This has been accomplished by a first aspect of the invention as defined in claim 1 being directed to a voltage stabilizing system configured to operatively stabilize the power voltage provided by an electric power storage to an electrical system and to a starter motor during crank of an engine of a vehicle. The stabilizing system comprises a starter switch arrangement and a control unit arrangement configured to operatively establish and terminate a communication of electric power between the power storage and the starter motor of the vehicle to crank the engine. The control unit is configured to operatively establish said communication of electric power such that the power provided from the power storage to the starter motor is repeatedly turned off for a period of time Δt_{off} each time the power voltage drops below a reference voltage during crank of the engine.

[0012] An embodiment of the invention comprising the features of the first aspect is directed to a control unit

configured to operatively determine a duty cycle of the starter switch arrangement during crank of the engine.

[0013] An embodiment of the invention comprising the features of the first aspect is directed to a control unit configured to operatively set the reference voltage to a predetermined value, or to alter the reference voltage so as to allow a lower value for the reference voltage during at least a period of the crank.

[0014] A particular embodiment of the invention comprising the features of the first aspect is directed to a control unit configured to operatively set the period of time Δt_{off} during which the power to the starter motor is turned off to a predetermined value, or to alter the period of time Δt_{off} during at least a period of the crank.

[0015] An embodiment of the invention comprising the features of said particular embodiment is directed to a control unit configured to operatively determine the period of time Δt_{off} in a variable manner depending on the rate at which the power voltage drops.

[0016] An embodiment of the invention comprising the features of said particular embodiment is directed to a control unit configured to operatively determine the period of time Δt_{off} in a variable manner depending on the duration Δt_{on} of a previously established communication of power.

[0017] Similarly, at least one of the drawbacks identified above has been eliminated or mitigated by a second aspect of the invention defined in claim 8 being directed to a method in a voltage stabilizing system for stabilizing the power voltage provided by an electric power storage to an electrical system and to a starter motor during crank of an engine in a vehicle. The stabilizing system comprises a starter switch arrangement and a control unit arrangement configured to operatively establish and terminate a communication of power between the power storage and the starter motor of the vehicle to crank the engine. The method comprises the steps of communicating power from the power storage to the starter motor during crank of the engine, and temporarily terminating said communication of power for a period of time Δt_{off} each time the power voltage drops below a reference voltage during crank.

[0018] An embodiment of the invention comprising the features in said second aspect is directed to a method comprising the steps of determining a duty cycle of the starter switch arrangement during crank of the engine.

[0019] An embodiment of the invention comprising the features in said second aspect is directed to a method comprising the steps of setting the reference voltage to a predetermined value, or altering the reference voltage so as to allow a lower value for the reference voltage during at least a period of the crank.

[0020] A special embodiment of the invention comprising the features in said second aspect is directed to a method comprising the steps of setting the period of time Δt_{off} during which the power to the starter motor is turned off to a predetermined value, or altering said period of time Δt_{off} during at least a period of the crank.

[0021] An embodiment of the invention comprising the features in said special embodiment is directed to a method comprising the steps of determining the period of time Δt_{off} in a variable manner depending on the rate at which the power voltage drops.

[0022] An embodiment of the invention comprising the features in said special embodiment is directed to a method comprising the steps of determining the period of time Δt_{off} in a variable manner depending on the duration Δt_{on} of a previously established communication of power.

[0023] The solution according to embodiments of the present invention avoid disadvantages associated with prior art. Particularly, the invention uses a simple and cost effective switching of the starter switch arrangement that depend on the power voltage provided by the electric power storage so as to stabilize the voltage in the electrical system during crank of the engine. As a contrast, a prior art voltage stabilizing method indicated in the background section uses two full sized expensive and heavy batteries. Another prior art method indicated in the background uses a complicated and expensive DC/DC-converter.

[0024] It should be emphasized that the invention provides a switching that depend on the power *voltage* provided by the electric power storage. This has me decisive advantage of securing a sufficient voltage level to the ECU:s and other similar electronic and/or computerized units of the vehicle in question. Indeed, it is not adequate to provide a sufficient power to electronic and/or computerized units in a vehicle (e.g. increasing the current to compensate for a voltage drop), since the operation of such units depend on a certain minimum voltage level. This is not the case for other vehicle components such as windshield wipers and other more or less passive components etc.

[0025] Further advantages of the present invention and embodiments thereof will appear from the following detailed description of the invention.

[0026] It should be emphasized that the term "comprises/comprising" when used in this specification is taken to specify the presence of stated features, integers, steps or components, but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] The present invention will now be described in more detail in relation to the enclosed drawings, in which:

Fig. 1 is a schematic illustration of a vehicle 1000 in which an embodiment of the invention is implemented,

Fig. 2a is a schematic illustration of the voltage provided from a vehicle starter battery during an ordinary crank of a combustion engine of a vehicle,

- Fig. 2b is a schematic illustration of the voltage provided from the battery 130 during a crank of the combustion engine 110 of the vehicle 1000 in Fig. 1,
- Fig. 3 is a schematic illustration of a voltage protection unit 300 according to an exemplifying embodiment of the invention,
- Fig. 4 shows a flowchart of a method according to an embodiment of the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Features in embodiments

[0028] The invention deals with problems caused to the electrical system of a motor vehicle during crank of the vehicle engine, e.g. in connection with the start-stop concept on motor vehicles. As indicated in the background, the start-stop concept means that the combustion engine or similar of a vehicle will be stopped when the velocity of the vehicle is below or equal to a certain threshold value (*i.e.* $<X$ km/h), *e.g.* when the vehicle has come to a complete stop. Then, when the driver wants to drive off the vehicle automatically starts the engine based on information from sensors *e.g.* sensing the actuation of clutch, brake or throttle pedal or similar. The start-stop concept is introduced to save fuel and to reduce the CO₂ emissions.

[0029] However, when the engine in a start-stop vehicle or similar is stopped and then started by means of an automated crank the voltage to the electrical systems of the vehicle will drop (*e.g.* as low as down to about 5-7 V) due to the high current consumption of the starter motor. In a normal crank (when the driver turns the ignition key) in a conventional vehicle, most electrical systems may be turned off in a controlled manner. However, in a start-stop vehicle the electrical systems must be kept on, *e.g.* the ECU:s (Electronic Control Units) of the vehicle shall not reset. In general, the driver shall not experience any functional losses. For example, the electrical systems of a typical passenger car is designed for a voltage between 9-16V. If the voltage drops below about 9V the ECU:s may reset and the diagnostic systems etc will create fault responses and cause disturbances on the electrical system.

[0030] In view of the above, Fig. 1 shows a schematic image of an improved voltage stabilizing system 300 implemented in an exemplifying vehicle 1000 according to an embodiment of the present invention. As can be seen in Fig. 1 the exemplifying vehicle 1000 comprises a combustion engine 110, a starter motor 120 for starting the engine 110, a battery 130 or similar electrical power source, a starter switch arrangement 124 connected to the starter motor 120 and the battery 130 for energizing the starter motor 120 and a control unit 140 for controlling the actuation of the starter switch arrangement 124. It is preferred that the battery 130 is additionally configured

to provide electrical power to other systems of the vehicle 1000, particularly the general electrical system 150 of the vehicle 1000.

[0031] The vehicle 1000 mentioned above may be an automobile or a motor car, *e.g.* a passenger car or similar. However, embodiments of the invention can be implemented in other wheeled motor vehicles that carries its own engine, *e.g.* mopeds or motorcycles (*e.g.* three wheeled mopeds and/or motorcycles) and lorries or trucks or similar. The vehicle is preferably a start-stop concept motor vehicle. However, the invention may also be implemented in almost any vehicle using an ordinary crank.

[0032] The engine 110 mentioned above may *e.g.* be any combustion engine or similar used in connection with automobiles or similar, *e.g.* an internal combustion engine.

[0033] The starter motor 120 mentioned above may be any starter motor suitable for starting a combustion engine or similar. Hence, the starter motor 120 may *e.g.* be a permanent-magnet or a series- or series-parallel wound direct current electric motor or similar. Embodiments of the invention can also be implemented in connection with other electrically powered starter motors, *e.g.* electrical starter motors that at least partly utilize hydraulic and/or pneumatic principles or similar.

[0034] Preferably, the starter motor 120 does not comprise a solenoid switch, which is common and well known in the art. In brief, when a current is applied to the solenoid of a common starter motor it pushes out a drive pinion on a starter driveshaft and meshes the pinion with a ring gear on a flywheel of the engine to be started so as to rotate and start the engine. As a contrast, it is preferred that the starter motor 120 in Fig. 1 is configured to rotate the engine 110 in a substantially direct manner without the need of pushing out any drive pinion or similar. For example, a drive pinion on a shaft of the starter motor 120 may be configured to interact substantially directly (without being pushed or similar) with a flywheel of the engine 110 so as to rotate the engine 110 during crank. This provides a decisive advantage in terms of reduced design complexities and cost reductions etc.

[0035] The battery 130 mentioned above is preferably arranged so as to be operatively used both for cranking the engine 110 of the vehicle 1000 and for supplying electrical power to the electrical system 150 of the vehicle 1000. The battery 130 may alternatively be a supercapacitor or a fuel cell or any other suitable electric power storage device.

[0036] The control unit 140 mentioned above may be implemented by means of hardware and/or software, and it may comprise one or several hardware units and/or software modules, *e.g.* one or several separate processor arrangements provided with or having access to the appropriate software and hardware required for the functions to be performed by the control unit 140 as will be described in more detail below. Moreover, the control unit 140 is preferably connected to the central control

system (not shown) of the vehicle 1000 so as to receive information from vehicle sensors, e.g. such as speed sensors and/or sensors configured to detect any actuation of the clutch pedal and/or the break pedal and/or the throttle pedal and/or the ignition switch and/or the presently selected gear, or a voltmeter detecting the voltage currently provided by the battery 130 etc. This may e.g. be accomplished by connecting the control unit 140 to a central communication network 1010 of the vehicle, which in turn is connected to the central control system of the vehicle 1000. The communication network 1010 may e.g. be a CAN-bus or a MOST-network or a similar communication network as is well known in the art. Hence, the observant reader understands that the control unit 140 may receive information via the central communication network 1010 about the voltage currently provided by the battery 130. Alternatively, the control unit 140 may receive information about the voltage currently provided by the battery 130 from a voltmeter 145 or similar being connected to the control unit 140 and to the battery 130.

[0037] Furthermore, it is preferred that the electrical system 140 mentioned above comprises all of or at least a plurality of the various ECUs in the vehicle 1000. A modern motor vehicle is typically provided with a plurality of ECUs or similar. For example, the combustion engine 110 of the vehicle 1000 may be controlled by at least one ECU provided with the suitable hardware and software for adjusting the fuel delivery system and/or the ignition system. Many other hardware and/or software-operated ECUs may be utilized in modern vehicles. In addition, the electrical system 150 mentioned above may also comprise the vehicle infotainment systems or similar and also one or several of: exterior lights, display lights, interior lights, air-conditioning systems, heater blower and other air blowing systems, seat heaters, window heaters, wipers and similar.

[0038] The attention is now directed to Fig. 2a showing a schematic illustration of the voltage provided from the battery during an ordinary crank of the combustion engine of a known vehicle. As can be seen in Fig. 2a the battery voltage U_{batt} temporarily drops below a certain reference voltage U_{ref} due to the current consumption of the starter motor during crank of the vehicle engine. As previously discussed in the background section, this is not acceptable in a start-stop vehicle since it may cause a reduced capacity or even a complete stop/reset of the ordinary electrical systems that are supplied by the battery.

[0039] Now, this problem is solved by the embodiment of the present invention indicated above with reference to Fig. 1. The operation of this embodiment is schematically illustrated in Fig. 2b showing the voltage U_{batt} provided from the battery 130 to the starter motor 120 via the starter switch arrangement 124 during crank of the engine 110. As can be seen in Fig. 2b the voltage U_{batt} will temporarily drop during crank due to the current consumption of the starter motor 120, which is similar to the

known crank in Fig. 2a. However, in Fig. 2b the voltage U_{batt} from the battery 130 will not drop below the reference voltage U_{ref} and this is in contrast to the crank in Fig. 2a wherein U_{batt} actually drops below U_{ref} .

[0040] Indeed, the voltage U_{batt} from the battery 130 during the crank in Fig. 2b will not drop below the reference voltage U_{ref} since the power from the battery 130 to the starter motor 120 is turned off by the starter switch arrangement 124 when the voltage U_{batt} drops below the reference voltage U_{ref} . More precisely, during crank of the engine 110 the duty cycle of the starter switch arrangement 124 and thus the starter motor 120 is determined such that power is provided from the battery 130 to the starter motor 120 while crank is active (i.e. Active Crank, see Fig. 4), and then repeatedly turned off for a short period of time Δt_{off} each time the voltage U_{batt} provided by the battery 130 drops below the reference voltage U_{ref} .

[0041] The reference voltage U_{ref} may e.g. be set to any value less than approximately 11V, or less than approximately 10,5V, or less than approximately 10V, or less than approximately 9,5V, or less than approximately 9V, or less than approximately 8,5V, or less than approximately 8V, or less than approximately 7,5V, or less than approximately 7V, or less than approximately 6,5V, or less than approximately 6V, or less than approximately 5,5V, or less than approximately 5V. However, it is preferred that U_{ref} is set to a value above approximately 0,5V. The reference voltage U_{ref} may be set to a *predetermined* value e.g. obtained by empirical studies. Alternatively, the reference voltage U_{ref} may be *dynamically* set e.g. depending on an allowable graceful degradation of the electrical system 150 of the vehicle 1000. For example, if the crank is demanding it may be possible to temporarily shut down systems that require a high voltage and/or has a high electric power consumption, which makes it possible to temporarily lower the reference voltage U_{ref} .

[0042] The duration Δt_{off} may be set to the same predetermined value through out the crank. Alternatively, the duration Δt_{off} may be dynamically altered during at least a period of the crank e.g. depending on the rate of the voltage drop when the crank is turned on. For example, a higher drop rate may give a longer Δt_{off} whereas a lower drop rate gives a shorter Δt_{off} or the other way around. Similarly, the duration Δt_{off} may be dynamically altered e.g. depending on the duration Δt_{on} of a previous crank on (e.g. the most recent crank on) before the crank is turned off - e.g. a longer Δt_{on} gives a shorter Δt_{off} while a shorter Δt_{on} gives a longer Δt_{off} or the other way around.

[0043] The attention is now directed to Fig. 3 showing a schematic illustration of a voltage stabilizing system 300 according to an exemplifying embodiment of the present invention. As can be seen in Fig. 3 and also in Fig. 1 it is preferred that the voltage protection unit 300 comprises the starter switch arrangement 124 and the control unit 140.

[0044] The starter switch arrangement 124 in Fig. 3 is preferably a semiconductor switch arrangement configured to connect the battery 130 to the starter motor 120 during a crank of the engine 110, i.e. during an ignition of the combustion engine 110 - which may be manually initiated or automatically initiated in a start-stop vehicle when the driver intends to drive off and/or intends to increase the velocity of the vehicle 1000. The semiconductor starter switch arrangement 124 is preferably implemented by a FET arrangement (Field Effect Transistor, FET) comprising one FET or a plurality of FETs in parallel. The FET in question may, e.g. be any of a MOSFET (Metal-Oxide-Semiconductor Field-Effect Transistor), a JFET (Junction Field-Effect Transistor), a MESFET (Metal-Semiconductor Field-Effect Transistor), a HEMT (High Electron Mobility Transistor) also called a HFET (Heterostructure Field-Effect Transistor), a MODFET (Modulation-Doped Field-Effect Transistor), FREDFET (Fast Reverse or Fast Recovery Epitaxial Field-Effect Transistor) or a DNAFAD or any other FET or FET-like switching device that is suitable for the various embodiments of the present invention.

[0045] The control unit 140 in the exemplifying embodiment shown in Fig. 3 is preferably implemented by means of a reference function 142, a comparator function 144, and an AND-function 146. Preferably, the control unit 140 comprises the necessary hardware and/or software for implementing these functions.

[0046] It is also preferred that the reference function 142 is configured to generate and/or comprise a value indicative of the reference voltage U_{ref} mentioned above. In a particular embodiment it is preferred that the reference function 142 is implemented by a memory circuit or similar comprising a *predetermined* or a *dynamically re-programmable* value or similar indicative of the reference voltage U_{ref} .

[0047] It is additionally preferred that the comparator function 144 is configured to compare values indicative of the voltages U_{ref} and U_{batt} mentioned above. In a particular embodiment it is preferred that the comparator function 144 is implemented by a hardware circuit and/or a software module configured to receive a value indicative of the voltage U_{ref} and a value indicative of the battery voltage U_{batt} mentioned above. Information about U_{batt} and/or U_{ref} may e.g. be provided from the communication network 1010 of the vehicle 1000 to which the voltage stabilizing system 300 and the comparator function 144 may be connected. Alternatively, U_{ref} may be provided from the reference function 142 mentioned above. Here it should be mentioned that the reference function 142 may be (re)programmed via the communication network 1010. It is further preferred that the comparator function 144 is configured to produce an active output value (e.g. a binary "one") when U_{batt} is on or above U_{ref} . However, other outputs indicative of the relation between U_{batt} and U_{ref} are clearly conceivable, e.g. a pulse pattern or similar.

[0048] Moreover, it is preferred that the AND-function

146 is configured to receive the output value from the comparator function 144 and a value (e.g. a binary "one") indicating whether a crank has been activated or not (c.f. the step "Active Crank" in Fig. 4). An active crank signal may e.g. occur in a start-stop vehicle when the driver intends to drive off and/or intends to increase the vehicle velocity as described above. Similarly, an active crank signal may occur when the driver turns the ignition key of the vehicle, which applies *mutatis mutandis* both for start-stop vehicles and conventional vehicles. Information about an active crank may e.g. be provided to the control unit 140 of the voltage protection unit 300 from the communication network 1010 of the vehicle 1000. It is further preferred that the AND-function 146 is configured to provide an activation signal or similar to the starter switch arrangement 124 each time a crank has been activated and U_{batt} is on or above U_{ref} as determined by the comparator function 144. The activation signal from the AND-function 146 to the starter switch arrangement 124 may e.g. correspond to the Crank On signal schematically illustrated in Fig. 2b. It is preferred that the AND-function 146 is implemented by a hardware circuit and/or a software module.

Operation of embodiments

[0049] The attention is now directed to the function of an exemplifying embodiment of the present invention. The embodiment is described with reference to Fig. 1-3, and Fig. 4 showing a flowchart illustrating the steps of an exemplifying method for providing improved voltage stabilization during crank of the engine in a motor vehicle. In the exemplifying embodiment it is preferred that the method is performed by means of the voltage stabilizing system 300 described above.

[0050] In a first step S1 of the exemplifying method it is preferred that the engine 110 of the vehicle 1000 is started. As is well known, this may e.g. be performed by the driver turning a starter key in the ignition lock or similar. It is preferred that step S1 also includes a drive off. It should be emphasized that the method now described is merely an exemplifying embodiment in which no voltage stabilizing is assumed during a start up of the vehicle 1000. However, in other embodiments of the invention the voltage may certainly be stabilized also during a start up crank.

[0051] In a second step S2 of the exemplifying method it is preferred that the control unit 140 checks whether a crank has been activated (Active Crank). A crank may e.g. be activated in a start-stop vehicle when the driver intends to drive off after a red light stop. The check may e.g. be performed by the control unit 140 requesting or receiving information about a crank activation from the communication network 1010 of the vehicle 1000. The control unit 140 continues to perform this check until a crank activation is detected. The process proceeds to the next step when this occurs.

[0052] In a third step S3 of the exemplifying method it

is preferred that the control unit 140 commands the starter switch arrangement 124 to power the starter motor 120 as previously described.

[0053] In a fourth step S4 of the exemplifying method it is preferred that the control unit 140 checks whether the voltage U_{batt} provided by the battery 130 is below the reference voltage U_{ref} as previously described. The method proceeds to the previous step S3 if the answer is no, whereas the method proceeds to the next step S5 if the answer is yes. Values indicative of U_{batt} and U_{ref} may generally be received and/or obtained via the network 1010 as previously described. Alternatively, values indicative of U_{batt} may be received from a voltmeter 145 to which the control unit 140 is connected and a value (or values if dynamically changed) indicative of U_{ref} may be comprised by a memory 142 of the control unit 140 as previously described.

[0054] In a fifth step S5 of the exemplifying method it is preferred that the control unit 140 commands the starter switch arrangement 124 to stop power the starter motor 120 for a period Δt_{off} as previously described. The method will then proceed to the first step S1.

[0055] The solution according to the embodiment of the invention discussed above avoids disadvantages associated with prior art. Particularly, the invention uses a simple and cost effective switching of the starter switch arrangement 124 that depend on the voltage U_{batt} provided by the starter battery 130 to stabilize the voltage in the electrical system 150 during crank of the engine 110. As a contrast, a prior art voltage stabilizing method indicated above in the background section uses two full sized expensive and heavy batteries. Another prior art method indicated in the background section uses a complicated and expensive DC/DC-converter.

[0056] In addition, it should be emphasized that the a switching depending on the voltage U_{batt} provided by the starter battery 130 has the decisive advantage of securing that a sufficient voltage level is provided to the ECU:s and similar of the vehicle 1000. Indeed, it is not sufficient to provide a sufficient power (e.g. increasing the current to compensate for a voltage drop), since the operation of ECU:s and similar depend on a certain minimum voltage level. This is not the case for other vehicle components such as windshield wipers etc.

[0057] It should also be emphasized that the solution according to preferred embodiments of the invention presupposes a starter motor 120 that is configured to rotate the engine 110 in a substantially direct manner without the need of complicated mechanics that is needed in prior art to push out a drive pinion or similar. This provides decisive advantages in terms of reduced design complexity and cost reductions etc.

[0058] The present invention has now been described with reference to exemplifying embodiments. However, the invention is not limited to the embodiments described herein. On the contrary, the full extent of the invention is only determined by the scope of the appended claims.

Claims

1. A voltage stabilizing system (300) configured to operatively stabilize the power voltage (U_{batt}) provided by an electric power storage (130) to an electrical system (150) and a starter motor (120) during crank of an engine (110) in a vehicle (1000), which stabilizing system (300) comprises a starter switch arrangement (124) and a control unit arrangement (140) configured to operatively establish and terminate a communication of electric power between the power storage (130) and the starter motor (120) of the vehicle (1000) to crank the engine (110), wherein;
the control unit (140) is configured to operatively establish said communication of power such that the power provided from the power storage (130) to the starter motor (120) is repeatedly turned off for a period of time (Δt_{off}) each time the power voltage (U_{batt}) drops below a reference voltage (U_{ref}) during crank of the engine (110).
2. The voltage stabilizing system (300) according to claim 1
wherein;
the control unit (140) is configured to operatively determine a duty cycle of the starter switch arrangement (124) during crank of the engine (110).
3. The voltage stabilizing system (300) according to claim 1
wherein;
the control unit (140) is configured to operatively set the reference voltage (U_{ref}) to a predetermined value, or to alter the reference voltage (U_{ref}) so as to allow a lower value for the reference voltage (U_{ref}) during at least a period of the crank.
4. The voltage stabilizing system (300) according to claim 1
wherein;
the control unit (140) is configured to operatively set the period of time (Δt_{off}) during which the power to the starter motor (120) is turned off to a predetermined value, or to alter the period of time (Δt_{off}) during at least a period of the crank.
5. The voltage stabilizing system (300) according to claim 4,
wherein;
the control unit (140) is configured to operatively determine the period of time (Δt_{off}) in a variable manner depending on the rate at which the power voltage (U_{batt}) drops.
6. The voltage stabilizing system (300) according to claim 4,
wherein;

the control unit (140) is configured to operatively determine the period of time (Δt_{off}) in a variable manner depending on the duration (Δt_{on}) of a previously established communication of power.

7. A vehicle (1000) provided with a voltage stabilizing system (300) according to any one of the preceding claims.

8. A method in a voltage stabilizing system (300) for stabilizing the power voltage (U_{batt}) provided by an electric power storage (130) to an electrical system (150) and a starter motor (120) during crank of an engine (110) in a vehicle (1000), which stabilizing system (300) comprises a starter switch arrangement (124) and a control unit arrangement (140) configured to operatively establish and terminate a communication of power between the power storage (130) and the starter motor (120) of the vehicle (1000) to crank the engine (110), which method comprises the steps of:

- communicating power from the power storage (130) to the starter motor (120) during crank of the engine (110),
- temporarily terminating said communication of power for a period of time (Δt_{off}) each time the power voltage (U_{batt}) drops below a reference voltage (U_{ref}) during crank.

9. The method according to claim 8, which method comprises the steps of: determining a duty cycle of the starter switch arrangement (124) during crank of the engine (110).

10. The method according to claim 8, which method comprises the steps of: setting the reference voltage (U_{ref}) to a predetermined value, or altering the reference voltage (U_{ref}) so as to allow a lower value for the reference voltage (U_{ref}) during at least a period of the crank.

11. The method according to claim 8, which method comprises the steps of:

- setting the period of time (Δt_{off}) during which the power to the starter motor (120) is turned off to a predetermined value, or altering said period of time (Δt_{off}) during at least a period of the crank.

12. The method according to claim 11, which method comprises the steps of:

- determining the period of time (Δt_{off}) in a variable manner depending on the rate at which the power voltage (U_{batt}) drops.

13. The method according to claim 11, which method comprises the steps of:

- determining the period of time (Δt_{off}) in a variable manner depending on the duration (Δt_{on}) of a previously established communication of power.

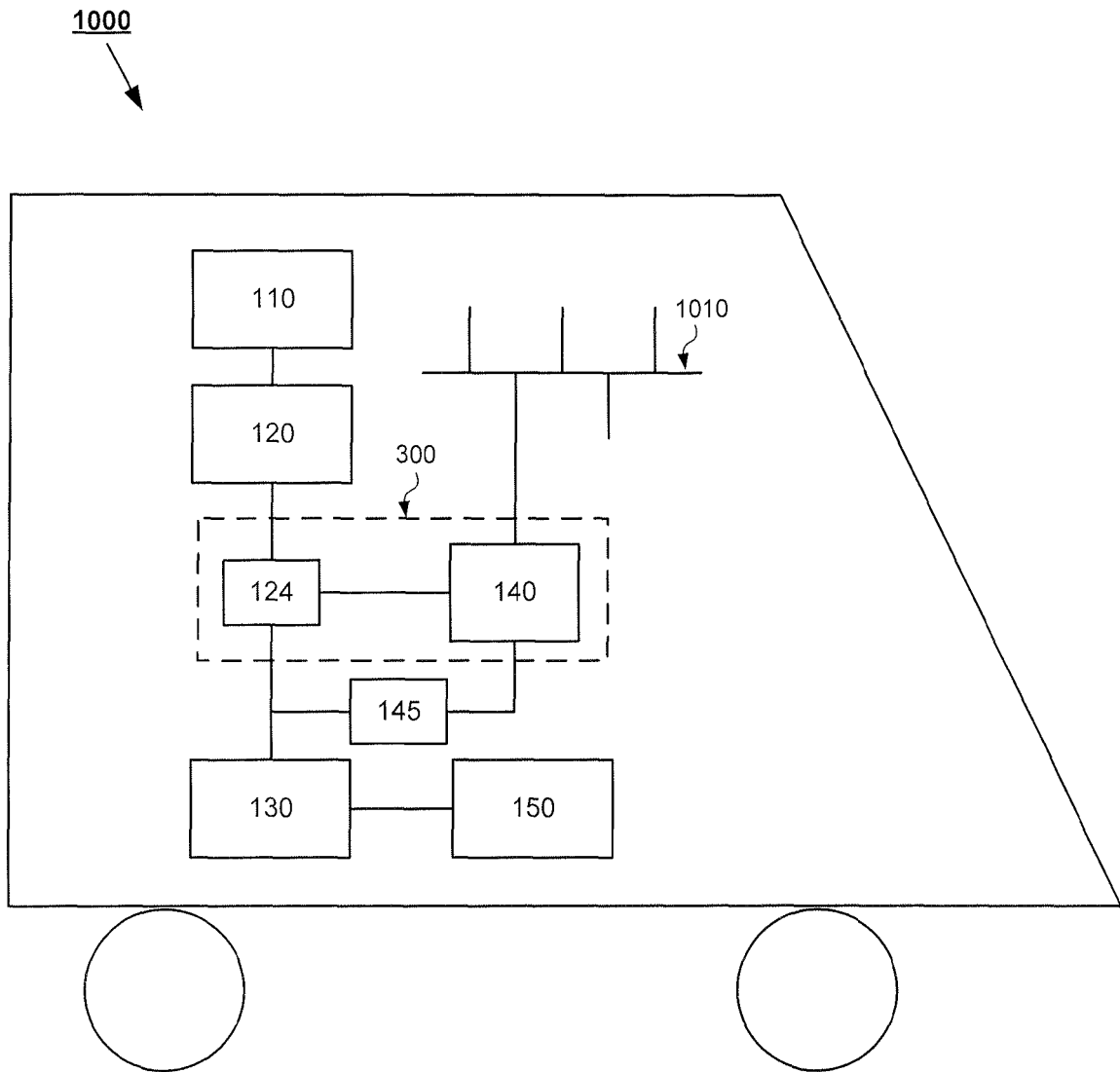


Fig. 1

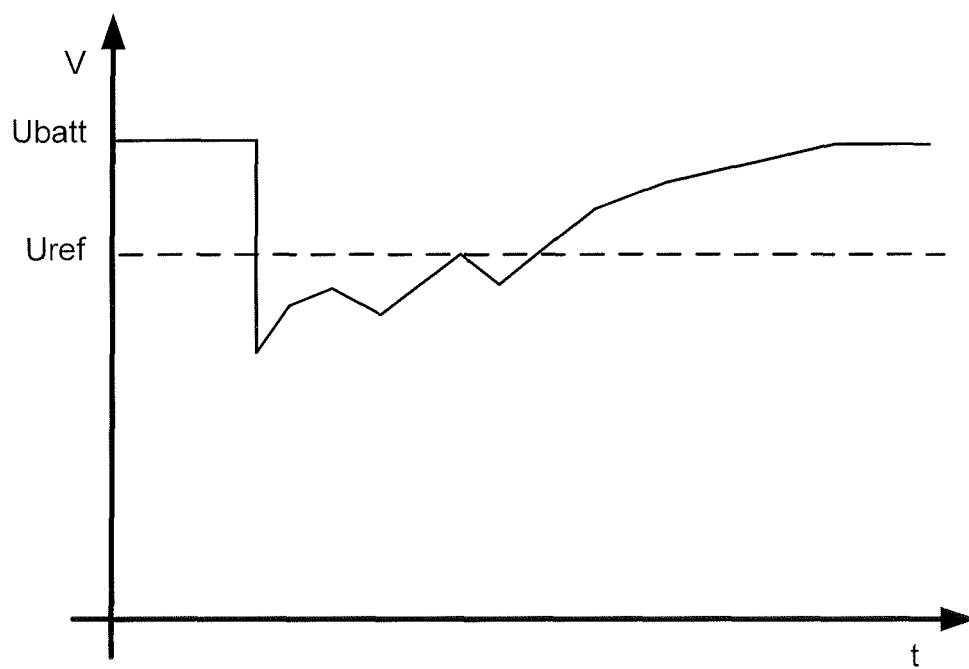


Fig. 2a

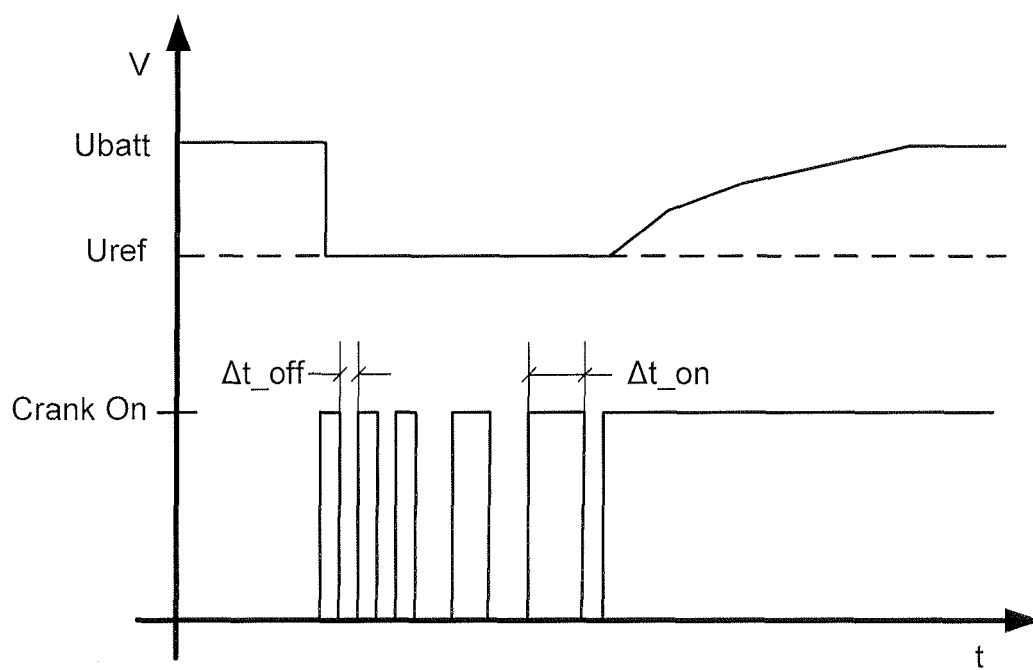


Fig. 2b

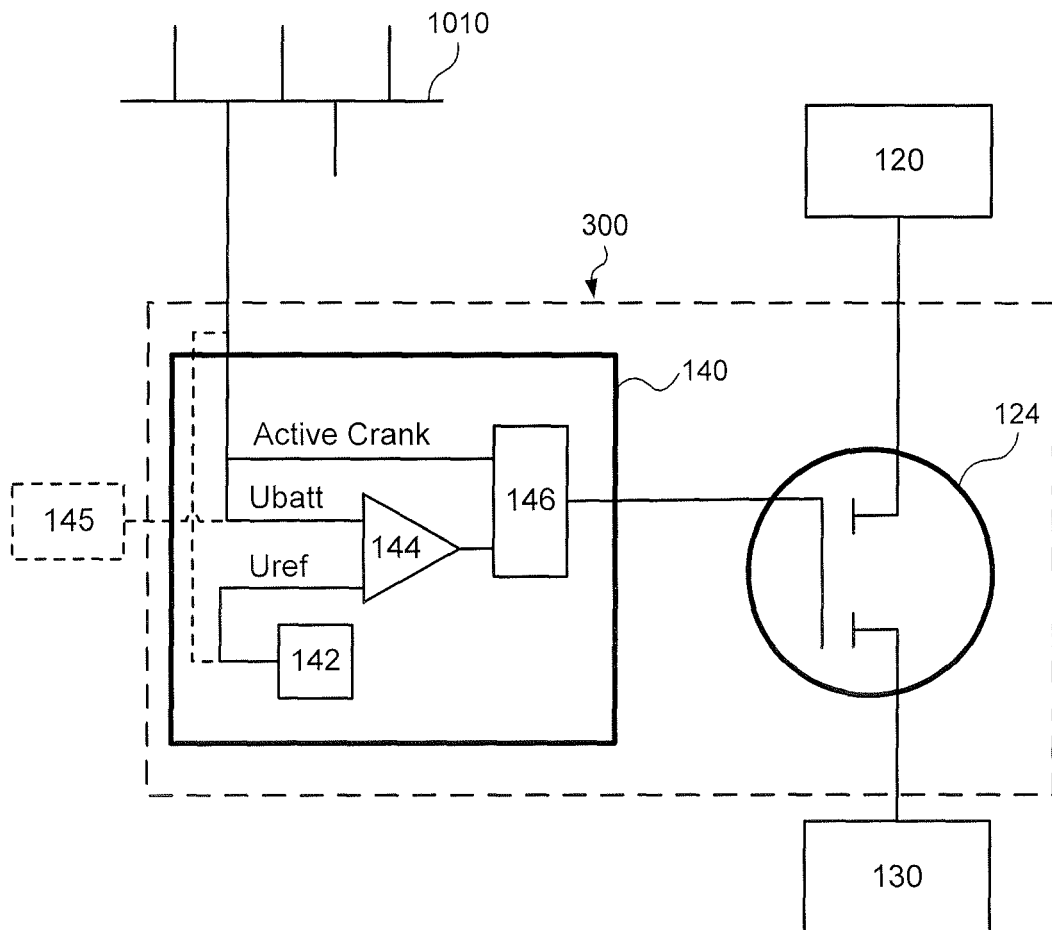


Fig. 3

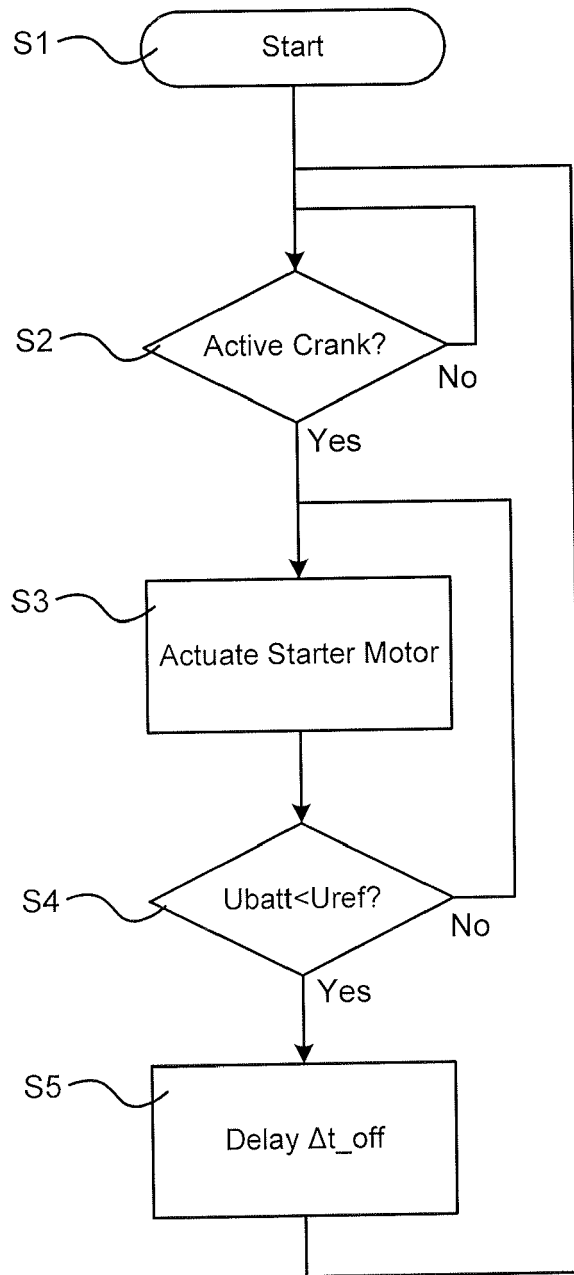


Fig.4



EUROPEAN SEARCH REPORT

Application Number
EP 08 16 5593

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 18 March 2009	Examiner Libeaut, Laurent
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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